IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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| Appellant: | Steven E. Ready et al. |
| Assignee: | Palo Alto Research Center Incorporated |
| Title: | Method for the Printing of Homogeneous Electronic Material with a Multi-Ejector Print Head |
| Serial No.: | 10/824,994 File Date: 04/14/2004 |
| Examiner: | Lam S. Nguyen Art Unit: 2853 |
| Docket No.: | A2242-US-DIV (XCP-030-1D) |

San Jose, CA
July 10, 2007

Mail Stop Appeal Brief-Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

**APPEAL BRIEF**

Sir:

This Appeal Brief, filed in triplicate, is in support of the Notice of Appeal dated July 10, 2007.

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**INDEX**

## I. REAL PARTY IN INTEREST

The real party in interest is the assignee, Palo Alto Research Center, Inc., pursuant to the Assignment recorded in the U.S. Patent and Trademark Office on August 20, 2002 on Reel 013218, Frame 0113.

## II. RELATED APPEALS AND INTERFERENCES

Based on information and belief, there are no other appeals or interferences that could directly affect or be directly affected by or have a bearing on the decision by the Board of Patent Appeals in the pending appeal.

## III. STATUS OF CLAIMS

Claims 10-20 are pending and stand rejected.

Claims 10-20 are appealed.

Claims 10-20 are listed in the Claims Appendix.

## IV. STATUS OF AMENDMENTS

Appellant filed a response to the Second Non-Final Office Action on May 24, 2006. The amendments entered in that response were entered by the Examiner, as indicated by the Examiner in the Final Office Action dated August 7, 2006.

## V. SUMMARY OF THE CLAIMED SUBJECT MATTER

This appeal involves independent Claim 10, and the subject matter of this claim finds exemplary support in the specification and drawings as follows:

| SUBJECT MATTER | SPECIFICATION | DRAWINGS |
|---|---|---|
| 10. A printing system comprising: | Paragraph 0038, printing system 200. | Fig. 2 |
| a stage for supporting a substrate; | Paragraph 0038, stage 210<br><br>Paragraph 0054, stage 510 | Fig. 2<br><br>Figs. 5a, 5b,6a,6b |
| a print head including:<br><br>an ejector base, and<br><br>a plurality of ejectors mounted in the ejector base; | Paragraph 0038, print head 230, base 231, ejectors 240<br><br>Paragraph 0050, print head 430b, base 431b, ejectors 440<br><br>Paragraph 0051, print head 430c, base 431b, ejectors 440<br><br>Paragraphs 0054 and 0055, print head 530, base 531, ejectors 540(x) | Fig. 2<br><br>Fig. 4b<br><br>Fig. 4c<br><br>Figs. 5a, 5b,6a,6b |
| means for moving the print head in a first print direction and a second print direction across a substrate without changing a rotational orientation of the print head relative to the substrate, the first print direction and the second print direction being nonparallel; and | Paragraphs 0038 and 0039, computer/ workstation 290, printing support structure 280, stage 210; see also paragraph 0044 and 0045 ("print direction" defined) | Figs. 2, 3a |
| means for causing the plurality ejectors to | Paragraphs 0038 and 0039, | Figs. 2, 3a |

| | | |
|---|---|---|
| selectively eject material toward the substrate when the print head is moving in the first printing direction and for causing the plurality ejectors to selectively eject material toward the substrate when the print head is moving in the second printing direction, | computer/ workstation 290, printing support structure 280, stage 210; see also paragraph 0044 and 0045 ("print direction" defined) | |
| wherein the first plurality of ejectors are arranged on the ejector base in a first line, the first line being diagonal to the first print direction and the second print direction. | Paragraph 0050, print head 430b, base 431b, ejectors 440<br><br>also: Paragraph 0051, print head 430c, base 431b, ejectors 440<br><br>also: Paragraphs 0054 and 0055, print head 530, base 531, ejectors 540(x) | Fig. 4b<br><br>Fig. 4c<br><br>Figs. 5a, 5b,6a,6b |

## VI. GROUNDS FOR REJECTION TO BE REVIEWED ON APPEAL

The following rejections are presented to the Board of Appeals for decision:

1. Claims 10-11 and 15 are rejected under 35 USC 103(a) as being unpatentable over USP 6390597 (herein "Fujimoto") in view of US 2001/0019340 (herein "Kubo").

2. Claims 10, 13 and 15-20 are rejected under 35 USC 103(a) as being unpatentable over USP 2002/0105688 (herein Katagami) in view of Kubo.

3. Claim 12 is rejected under 35 USC 103(a) as being unpatentable over Fujimoto in view of Kubo, and further in view of USP 5936648 (herein "Minowa").

4. Claim 14 is rejected under 35 USC 103(a) as being unpatentable over Katagami in view of Kubo, and further in view of legal precedent.

## VII. ARGUMENTS

Claims 10 is patentable under 35 U.S.C. 103(a) over either Fujimoto or Katagami in view of Kubo

Claim 10 recites (in pertinent part; emphasis added):

> A printing system comprising:
>
> ...means for moving the print head in a first print direction and a second print direction across a substrate without changing a rotational orientation of the print head relative to the substrate, **the first print direction and the second print direction being nonparallel**; and
>
> **means for causing the plurality ejectors to selectively eject material toward the substrate when the print head is moving in the first printing direction and** for causing the plurality ejectors to selectively eject material toward the substrate **when the print head is moving in the second printing direction**,
>
> wherein the first plurality of ejectors are arranged on the ejector base in a first line, the first line being diagonal to the first print direction and the second print direction.

The structure recited in Claim 10 is generally directed to Integrated Circuit (IC) printing, which is an emerging technology that attempts to reduce the costs associated with IC production by replacing expensive lithographic processes with simple printing operations (see Applicants' paragraph 0003). Conventional IC printing typically involves depositing a print solution (generally an organic material) by raster bitmap along a single axis (the "print travel axis") across a solid substrate (see paragraph 0004). As described in Applicant's paragraph 0006, if first and second droplets are applied onto the substrate within a time prior to the phase transformation of the first droplet, the second droplet will wet and coalesce to the first droplet in its liquid or semi-liquid state to form a continuous printed

feature. Fig. 1a (copied below) shows a photograph of a printed feature 100a that was printed in a single printing pass in the X axis direction. Because adjacent droplets deposited during the single printing pass did not have time to dry between ejection events, feature 100a exhibits the desired homogeneity and smooth side wall profiles that result from optimal droplet coalescence. In contrast, Fig. 1b shows a photograph of a printed feature 100b formed by raster printing in the Y axis direction. Feature 100b therefore represents a "multi-pass" feature; i.e., a printed feature formed by multiple passes of the print head. In a multi-pass feature, the droplets deposited during sequential passes of the print head are typically dry before any adjacent droplets from the next printing pass are deposited. Consequently, the drops of print solution that make up the multi-pass feature are not able to coalesce and therefore create "scalloped" feature borders. This edge scalloping can be seen in Fig. 1b, as the individual print solution droplets 110b used to form feature 100b are all clearly visible:

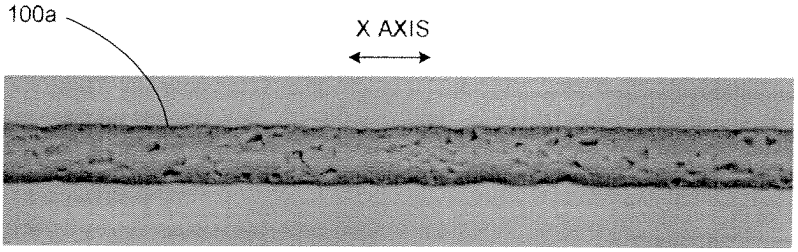



Fig. 1a

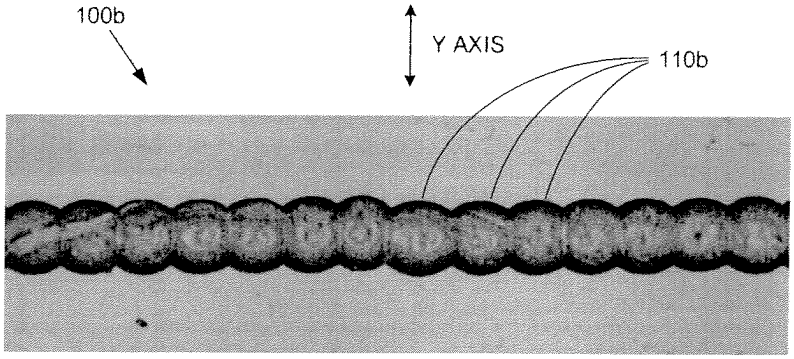



Fig. 1b

As further described in Applicants' paragraph 0007, utilizing printing systems that print in only one direction (e.g., the X axis direction) produce IC patterns that exhibit the undesirable edge scalloping and non-coalescence shown in Fig. 1(b):

**[0007]** Typically, an IC pattern includes both multi-pass features and features that are aligned with the print direction. Fig. 1c shows a photograph of an IC pattern 100c printed using a conventional IC printing process - in this case a raster printing operation in the Y axis direction. IC pattern 100c is made up of an array of transistor elements 120 interconnected by multiple address lines 160 and word lines 170. Word lines 170, which run parallel to the Y axis and were therefore aligned with the print direction, exhibit the desirable homogeneity and smooth sidewalls described with respect to Fig. 1a. However, address lines 160, which are printed by multiple printing passes in the Y axis direction, all exhibit the undesirable edge scalloping and non-coalescence described with respect to Fig. 1b.

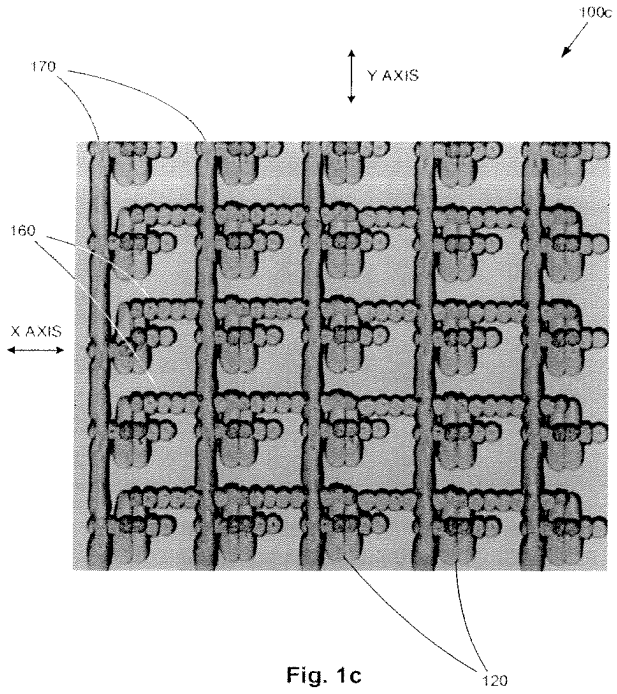



Fig. 1c
(PRIOR ART)

The structure of Claim 10 overcomes the problems described above by facilitating printing in two non-parallel directions, for example, as described in paragraph 0050 and shown in Applicants' Fig. 4, both copied below:

**[0050]** Fig. 4b shows a bi-axial print head in accordance with another embodiment of the invention. Print head 430b includes multiple ejectors 440 arranged in a diagonal line across an ejector base 431b. Note that while six ejectors are shown for explanatory purposes, print head 430b could include any number of ejectors. The diagonal ejector arrangement of print head 430b allows multi-line printing to be performed in both the X axis and Y axis directions without print head or substrate rotation. Note that the throughput capability of print head 431b can be further optimized by setting the horizontal spacing Hb and the vertical spacing Wb between ejectors 440 according to the design rules of the IC layout being printed, as described previously with respect to print head 430a shown in Fig. 4a.

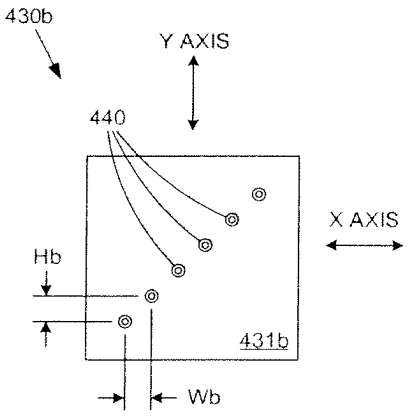



Fig. 4b

As described, for example, in Applicants' paragraph 0046 (copied below with Fig. 3d), the structure recited in Claim 10 facilitates the production of a printed pattern including homogenous printed patterns formed by a series of printing operations, wherein the print direction of each printing operation is aligned with the parallel layout features of the design layer being printed:

**[0046]** Fig. 3d shows a photograph of an IC pattern 300d that could be printed from design layers 300b and 300c in Figs. 3b and 3c, respectively. Note that word lines 360 of IC pattern 300d, which were formed by a printing operation having a print direction parallel to the Y axis, all exhibit the desired smooth edges and homogeneity previously described with respect to printed feature 100a shown in Fig. 1a. Similarly, note that address lines 370, which were formed by a printing operation having a print direction parallel to the X axis, are likewise smooth-edged and homogenous. In this manner, division of IC layouts into appropriate design layers can enable improved printing of IC patterns. Contrast the smooth-edges of IC pattern 300d with the scalloped edges of IC pattern 100c shown in Fig. 1c, which was formed using a conventional printing method.

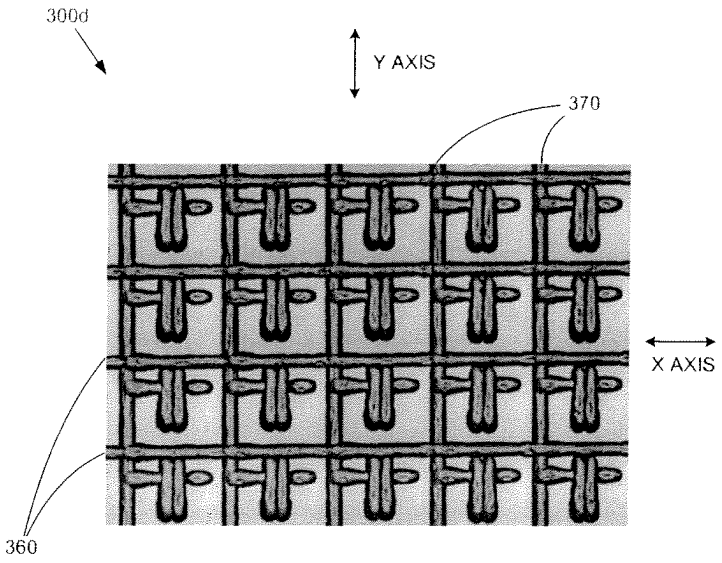



**Fig. 3d**

a) <u>The pending rejections clearly rely on Kubo to teach printing in two non-parallel directions</u>

In rejections 1 and 2 (listed above), the Examiner admits that neither Katagami nor Fujimoto disclose "means for causing the plurality ejectors to selectively eject material toward the substrate when the print head is moving in the first printing direction and for causing the plurality ejectors to selectively eject material toward the substrate when the print head is moving in the second printing direction". Specifically, on page 3 of the final Office

action, the Examiner state:

> Fujimoto et al., however, does not disclose wherein said means for causing the plurality ejectors causes the plurality ejectors to selectively eject material toward the substrate when the print head is moving in the second direction.

Similarly, on page 5 of the final Office Action, the Examiner states:

> Katagami et al., however, does not disclose wherein said means for causing the plurality ejectors causes the plurality ejectors to selectively eject material toward the substrate when the print head is moving in the second direction.

In each case, the Examiner then relies on Kubo to meet the missing limitation (see both pages 3 and 5):

> **Kubo et al. discloses an inkjet printer including an inkjet head (FIG. 1, element 151) configured to move in both X and Y scanning directions and comprising a plurality of ejectors (nozzles) (*FIG. 3A, element 152*) selectively discharging color inks during the movement of the inkjet printhead in the X and Y scanning directions (first and second directions) (*FIG. 1*).**

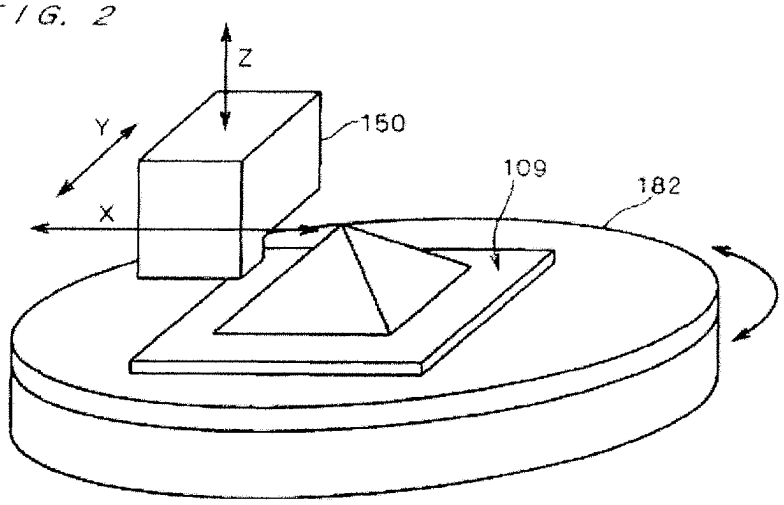
The Examiner then argues that it would have been obvious to combine the teachings of Funjimoto/Kanigawa and Kubo (see pages 3 and 5).

b) Kubo clearly fails to teach printing in two non-parallel directions

Applicant respectfully traverses the pending rejections of Claim 10 at least because Kubo fails to teach or suggest "means for causing the plurality ejectors to selectively eject material toward the substrate when the print head is moving in the first printing direction and...when the print head is moving in the second printing direction" wherein "the first print direction and the second print direction being

nonparallel…", as recited in Claim 10. As previously argued by Appelant in the Response filed October 25, 2005 in a rejection directed to Claim 1 (now canceled) of the present application, Kubo teaches a system in which "the ejection head continuously **moves in the main scanning direction during a printing operation.**" (Kubo, paragraph 0013 emphasis added.) For example, in describing the operation of an ejection head 150 shown in FIG. 2 of Kubo (duplicated here for reference), Kubo explicitly states that:

FIG. 2




> [E]jection head 150 **ejects ink from its ejection nozzles while continuously moving in the main scanning direction X**, whereby a single line of printing in the main scanning direction X is performed on a target area of the printing object 109. **Upon completion of one printing operation in the main scanning direction X, the ejection head 150 is moved in the sub-scanning direction Y** and starts the **next printing operation in the main scanning direction X**. (Kubo, paragraph 0076, emphasis added.)

Nowhere does Kubo disclose or suggest printing in any other direction besides main scanning direction X. Accordingly, it would not have been possible to combine the teachings of Kubo with either Fujimoto or Katagami to produce a printing system including "means for causing the plurality ejectors to selectively eject material toward the substrate when the print head is moving in the first printing direction and...when the print head is moving in the second printing

direction" wherein "the first print direction and the second print direction being nonparallel...", as recited in Claim 10.

c) The current rejections appear to contradict the Examiner's previous arguments raised with respect to Kubo USP 6,60,958 in the Office Action dated July 26, 2005

Applicant respectfully points out that Kubo was previously cited by the Examiner in the Office Action dated July 26, 2005 that was entered in the present application. That Office Action cites Kubo USP 6,460,958, which issued from the same base application (i.e., 09/793,636) as Kubo 2001/0019340. Therefore, Applicant understands that Kubo USP 6,460,958 and Kubo 2001/0019340 are identical references and contain identical teachings.

The rejections currently raised, e.g., against Claim 10 in the present application with respect to Kubo 2001/0019340 appear to contradict the Examiner's earlier comments regarding Kubo USP 6,460,958 when cited against Claim 1 (now canceled). That is, Claim 1 originally recited a "print head being configured to print in a first direction and a second direction, the first direction and the second direction being nonparallel". In rejecting original Claim 1, the Examiner argued (in part, from 7/26/2005 Office Action, page 3, emphasis added):

> Kubo et al. discloses a print head (*FIG. 2, element 150*) for a printing system, the print head being configured to print in a first direction (*FIG. 2: The first direction is a printing/scanning direction when the printhead 150 is scanning in the X direction and forming image on the stationary substrate 10. In this case, the first direction is the X direction*) and a second direction (*FIG. 2: The second direction is a printing/scanning direction formed the same as the first direction after the substrate is rotated at an angle. Thus, the second direction is nonparallel to the first direction if the angle is not at 180 or 360 degrees*), the first direction and

the second direction being nonparallel (*Note: The claim is interpreted as that both first and second directions on the substrate are the same as the scanning direction of the printhead to form two printing lines (at different moments) angled with each other due to the rotation of the substrate*)...

In response to this rejection, Claim 1 was amended to recite (in pertinent part) "the printing system being configured to move the print head in a first print direction and a second print direction across a substrate without changing a rotational orientation of the print head relative to the substrate" (see AMENDMENT IN RESPONSE TO THE FIRST OFFICE ACTION filed October 26, 2005). **After this amendment the rejections based on Kubo were withdrawn.**

Similar to amended Claim 1 (now canceled), current Claim 10 recites (in pertinent part) "means for moving the print head in a first print direction and a second print direction across a substrate without changing a rotational orientation of the print head relative to the substrate, the first print direction and the second print direction being nonparallel". Thus, in apparent contradiction to the arguments raised in the rejection of Claim 1 (discussed above), the Examiner now appears to take the position that Kubo teaches printing in both the X and Y directions "without changing a rotational orientation of the print head relative to the substrate" as currently recited in Claim 10. However, as set forth above in section b), Kubo clearly teaches rotating the print head in order to print in two (X and Y) directions, as clearly admitted in the rejection to Claim 1 entered by the Examiner in the 7/26/2005 Office Action. Thus, the rejection over Fujimoto/Katagami in view of Kubo is erroneous, and should be withdrawn.

d) Claims 11-20 depend from Claim 10, and none of the additional references overcome the defiencies of Kubo

Claims 11-20 are dependent from Claim 10, and are therefore distinguished over Fujimoto/Katagami in view of Kubo for at least the reasons provided above with reference to Claim 10. In addition, Minowa does not overcome the deficiencies of Kubo, and Applicant respectfully submits that legal precedent cannot be relied upon to maintain the rejection.

For the foregoing reasons, it is submitted that the Examiner's rejections of Claims 10-20 are erroneous, and reversal of these rejections is respectfully requested.

Respectfully submitted,

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## VII. CLAIMS APPENDIX

10. (previously presented) A printing system comprising:

a stage for supporting a substrate;

a print head including:

an ejector base, and

a plurality of ejectors mounted in the ejector base;

means for moving the print head in a first print direction and a second print direction across a substrate without changing a rotational orientation of the print head relative to the substrate, the first print direction and the second print direction being nonparallel; and

means for causing the plurality ejectors to selectively eject material toward the substrate when the print head is moving in the first printing direction and for causing the plurality ejectors to selectively eject material toward the substrate when the print head is moving in the second printing direction,

wherein the first plurality of ejectors are arranged on the ejector base in a first line, the first line being diagonal to the first print direction and the second print direction.

11. (previously presented) The printing system of Claim 10, wherein the first print direction and the second print direction are orthogonal.

12. (previously presented) The printing system of Claim 11, wherein the first line is at a 45° angle with respect to the first print direction and the second print direction.

13. (previously presented) The printing system of Claim 10, further comprising means for causing the print head to print an IC pattern on the substrate, wherein a first spacing between each of the first plurality of ejectors in the first print direction is an integer multiple of a first design rule of the IC pattern, and wherein a second spacing between each of the first plurality of ejectors in the second print direction is an integer multiple of a second design rule of the IC pattern.

14. (previously presented) The printing system of Claim 13, wherein the first design rule is the same as the second design rule.

15. (previously presented) The printing system of Claim 10, further comprising a second plurality of ejectors mounted in the ejector base, the second plurality of ejectors being arranged in a second line, the second line being parallel to the first line, wherein each of the first plurality of ejectors and the second plurality of ejectors has a unique position in the first print direction.

16. (previously presented) The printing system of Claim 15, further comprising a third plurality of ejectors mounted in the ejector base, the third plurality of ejectors being arranged in a third line, the third line being parallel to the first line, wherein each of the first plurality of

ejectors and the third plurality of ejectors has a unique position in the second print direction.

17. (previously presented) The printing system of Claim 10, further comprising means for causing the plurality of ejectors to print a phase change material for a semiconductor process mask.

18. (previously presented) The printing system of Claim 10, further comprising means for causing the plurality of ejectors to print a solution-processable electronic materials to form an integrated circuit.

19. (previously presented) The printing system of Claim 10, further comprising means for aligning the plurality of ejectors to the substrate before causing the plurality of ejectors to selectively eject said material toward the substrate.

20. (previously presented) The printing system of Claim 19, wherein said means for aligning comprises a camera mounted on said means for moving.

## IX. EVIDENCE APPENDIX

Not used.

## X. RELATED PROCEEDINGS APPENDIX

Not used.